sPHENIX TPC

Overview,

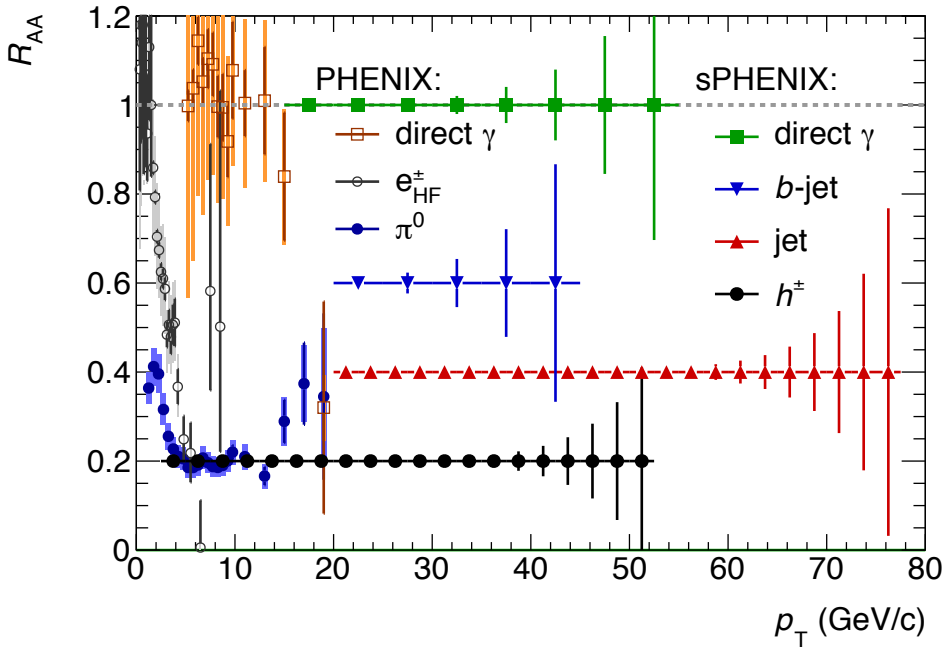
Design, and

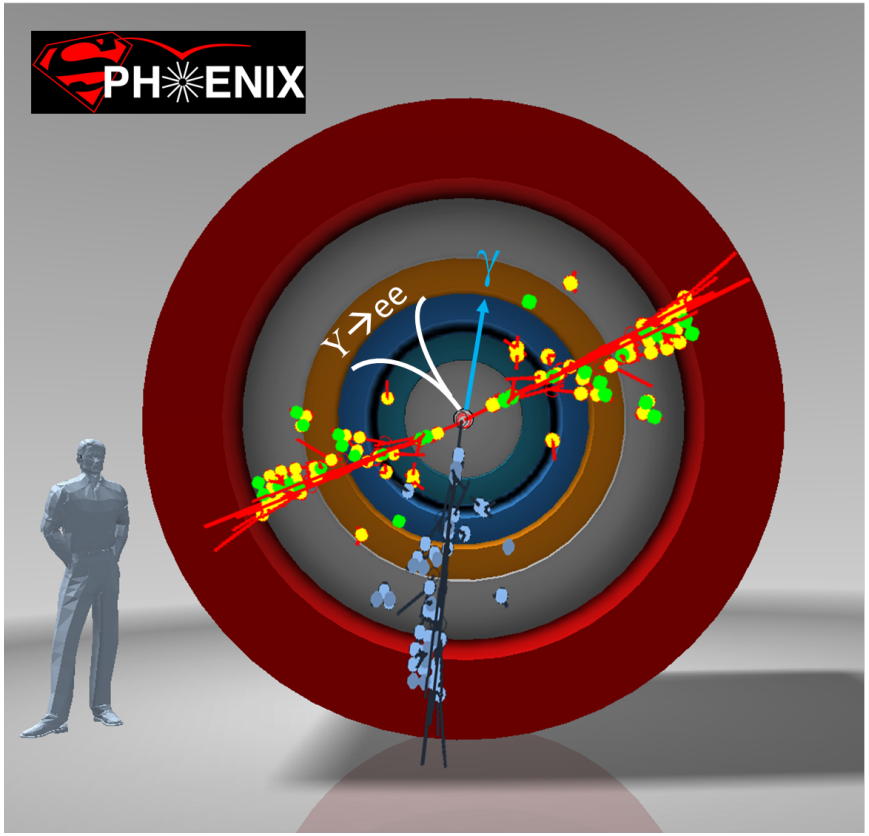
Planning

sPHENIX Physics Goals

http://www.phenix.bnl.gov/phenix/WWW/publish/documents/sPHENIX_proposal_19112014.pdf

- Jets and Beauty



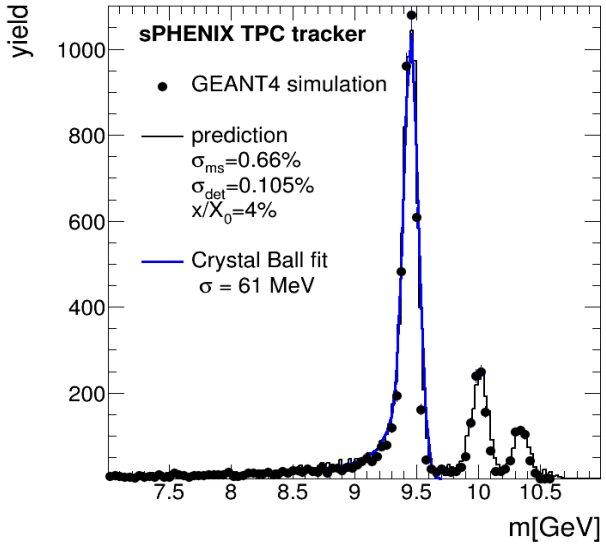


The physics does not require a TPC, but …

sPHENIX case for a TPC

… benefits are quantifiable !

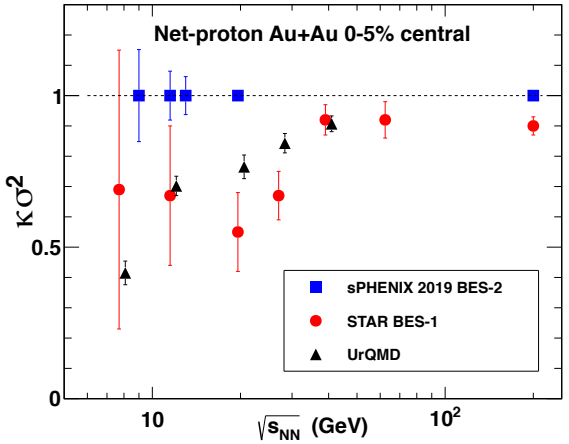
- Upsilon
  - $\Delta p/p \sim 1.2\%$ at 4-10 GeV/c
  - improved signal to noise with e-id
- Jet fragmentation
  - $\Delta p/p \sim 1\%$ p at low-z
  - $\Delta p/p \sim 0.2\%$ p at 40 GeV/c
- Jet-medium interactions

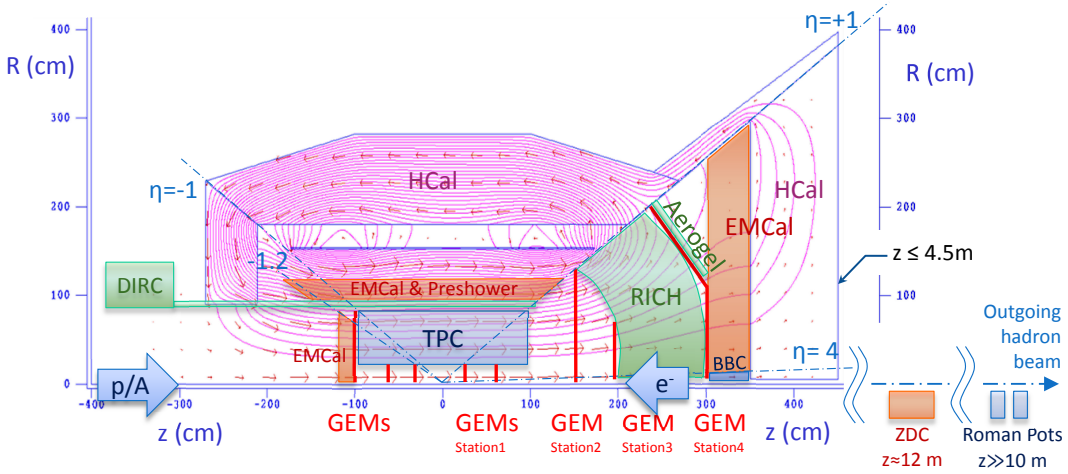


Add'nl short/long term benefits

http://www.phenix.bnl.gov/phenix/WWW/publish/dave/sPHENIX/BES_II_whitepaper.pdf

- Beam Energy Scan 2019-2020
  - Net-proton fluctuations
  - "Instant" soft-physics detector
- Electron Ion Collider >2025
  - Detector requirements have significant overlap





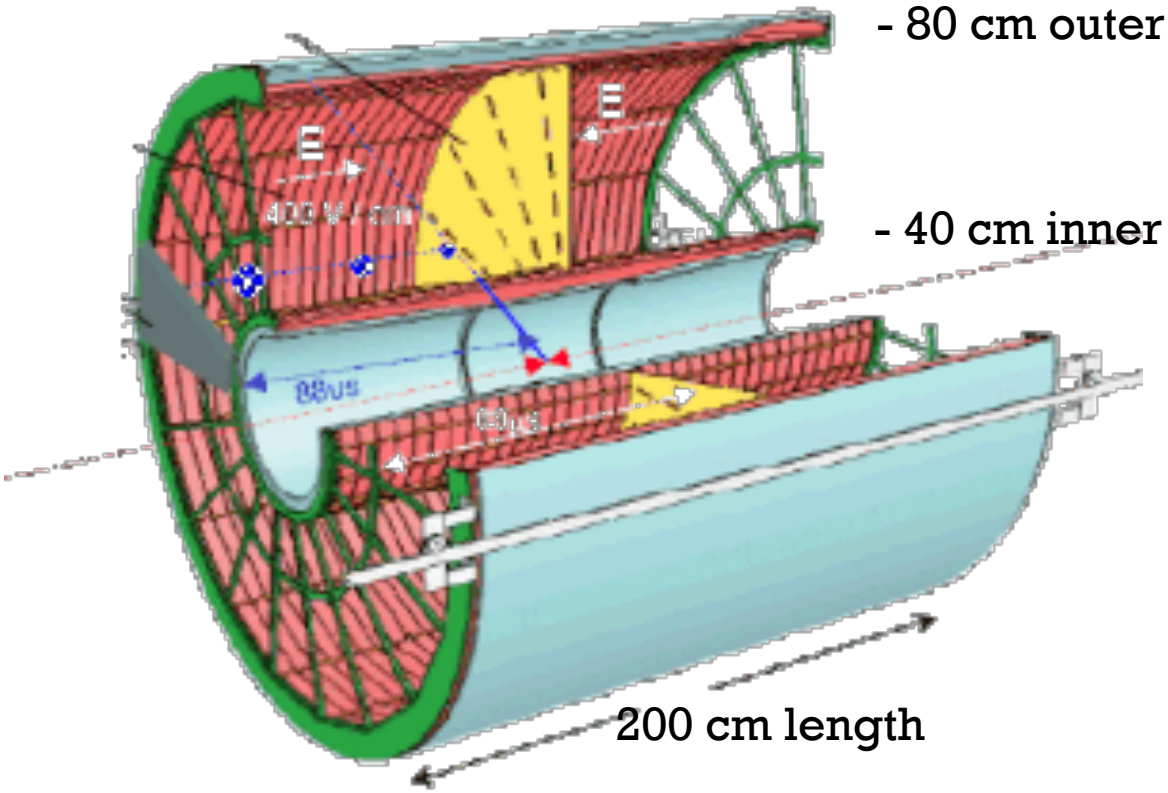
http://www.phenix.bnl.gov/phenix/WWW/publish/dave/PHENIX/ePHENIX_LOI_09272013.pdf

sPHENIX and EIC TPCs

- Requirements
  - similar geometry
  - similar magnetic fields (1.5 vs. 3 Tesla)
  - similar momentum resolution
  - similar M.B. trigger rates (~50 kHz)
  - higher track densities for sPHENIX (>10x)
- Considerations
  - location and day-1 beam are uncertain
  - TPC's often have >10 year longevity

Nominal sPHENIX TPC Design

- R_{outer}, B_{field}, length, fixed by BaBar Magnet



- 80 cm outer radius

- 40 cm inner radius

B = 1.45 Tesla
E = 200 V/cm
T2K gas (95-3-2)
3-Gem/MicroMega
SAMPA Chip Readout
r-pitch = 8 mm
ϕ-pitch = 1.2 mm
t-bucket = 40 ns

- Subject to physics/engineering optimization

TPC Design Tools (Today's Agenda)

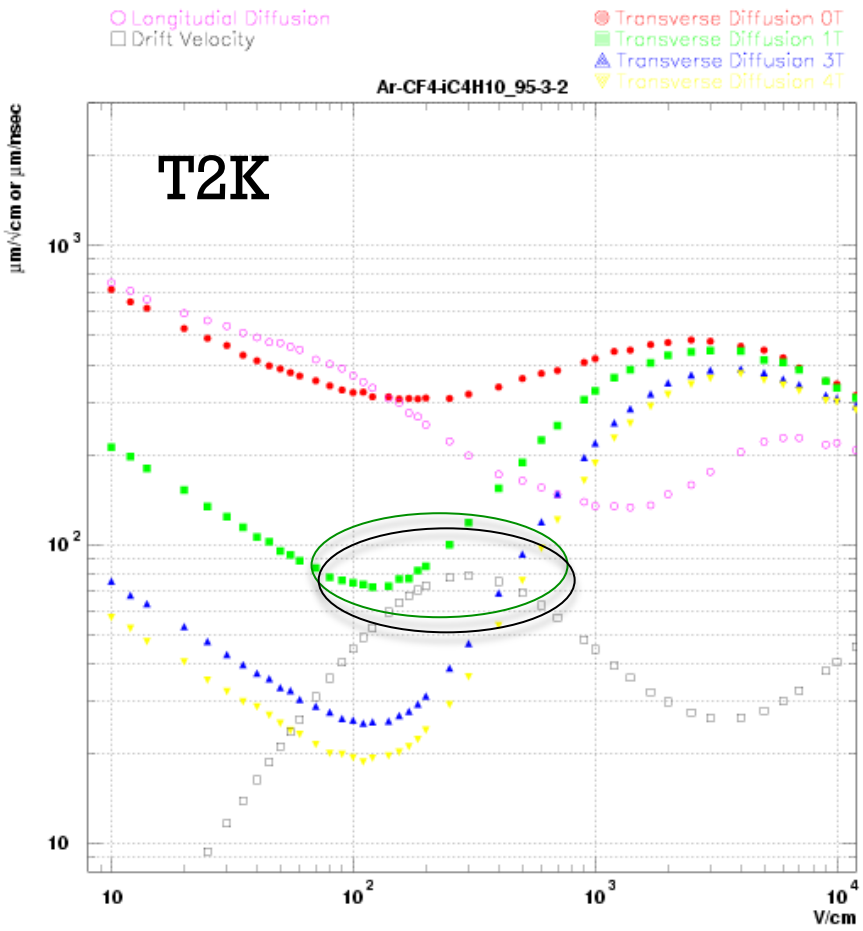
- Fast Simulator (Alan Dion)
  - validate with analytic forms
- Hardware R&D
  - Weizmann (Sasha Milov)
  - BNL (Craig Woody)
- Slow Simulator (Klaus Dehmelt)

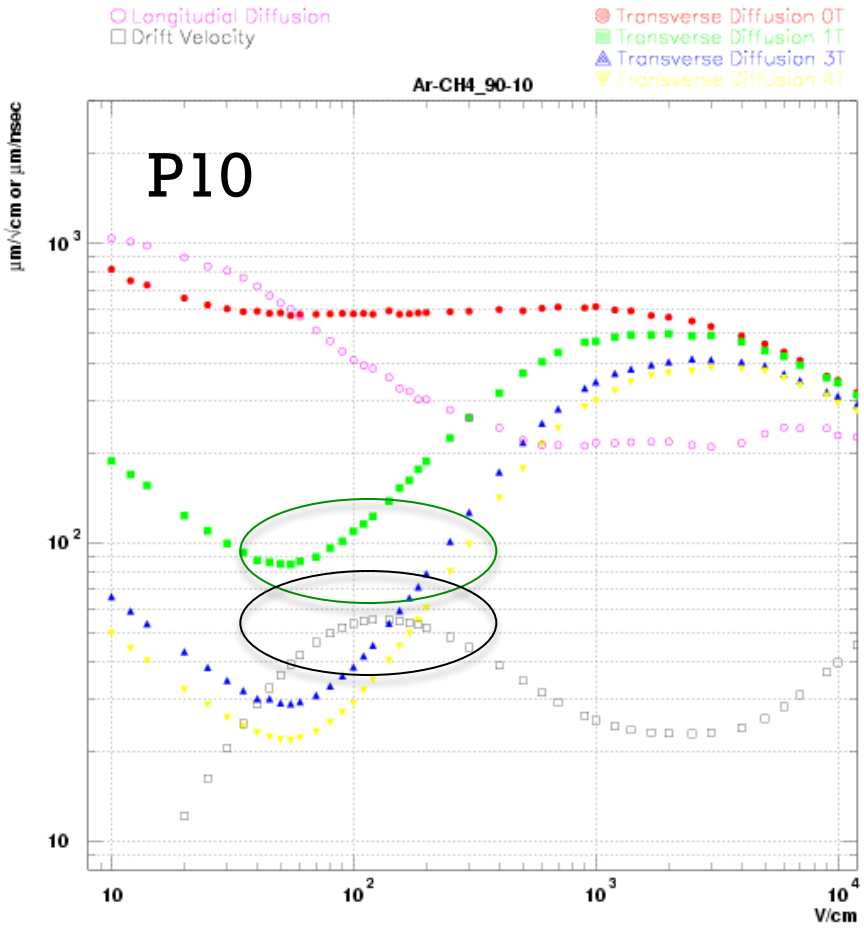
Physics Optimization Plans

- Caveat – "Everything in a TPC depends on everything else!"
- R_{outer}, B-field, Length can be fixed
- Gas/E-field, R_{inner}, Pad-size
  - highly interconnected
  - vary simultaneously
- Physics Criteria
  - Momentum/Upsilon mass resolution (single track)
  - Upsilon signal-to-noise (Hijing)
  - 2-track resolution (Hijing)

Drift Gas Options

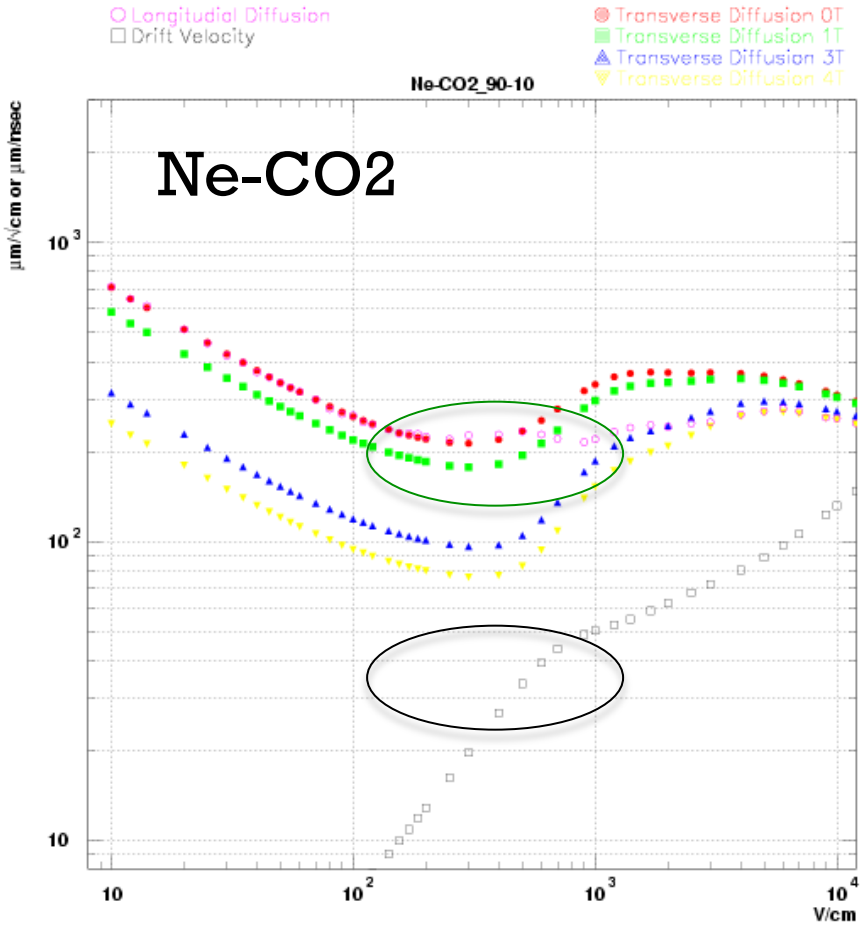
- T2K *vs* P10 : a little faster, less diffusion

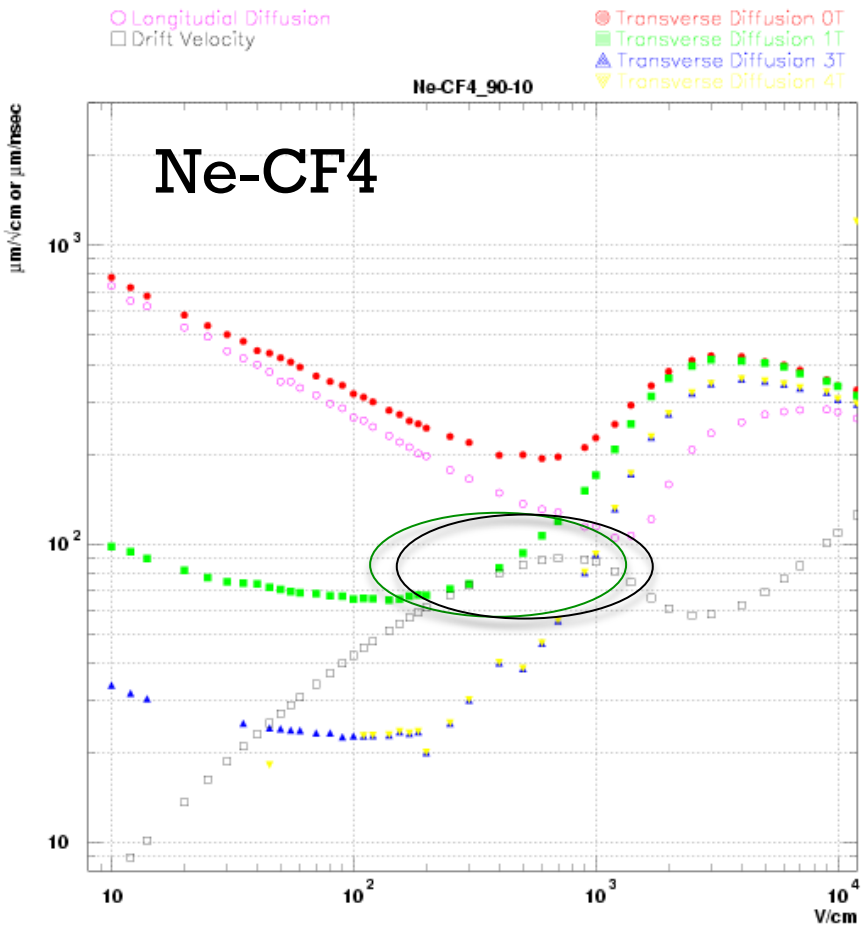




More Drift Gas Options

- ALICE : Ne for ion mobility, CO2 *vs.* CF4





Fast Simulator optimization plan

- Select representative set of gases and E-fields
  - T2K, P10, Ne-CO2, CF4
- For each gas, vary R_{inner} and pad-size
  - evaluate Upsilon mass with, efficiency, 2-track
    - evaluate single-drift volume for fast-gas
  - map to channel count, estimate cost
  - select optimal parameters for each choice

~2 FTE-months

Hardware R&D plan

- Gas amplification, ion-feed back, electronics
- Test chambers at Weizmann, BNL

1. Test Electronics
   - Acquire experience with SAMPA chip
     - available this summer 2015?
   - Other options? GET = General Electronics for TPC
   - Assume independent chip R&D beyond our reach
2. Gas gain and ion-feedback & mobility
   - 3-GEM and/or MicroMegas
3. Select and tune gas mixture

6-18 FTE-months

Slow Simulator

- Simulate full drift, diffusion, distortion
  - Input measurements from test chambers
  - Improve parameterizations in Fast Simulator
- Electrostatics to design field cage
- Other uses?

Other aspects

- Integration and support
  - Beam pipe impliciations
- Laser system and calibration
- Gas system
- High Voltage
- Cooling
- Monitoring

Feedback …

- Optimization plan
- Fast simulator design
- Hardware R&D plans and coordination
- Slow simulator
- Anything we haven't thought of …